July 28, 2005 Docket: TM-04-07

Arthur Neal
Director, Program Administration
National Organic Program
USDA-AMS-TMO-NOP
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Dear Mr. Neal and National Organic Standards Board:

This letter is in reference to the National Organic Program, Sunset Review, Docket number TM-04-07. **Dole Fresh Fruit International, Ltd**. supports the allowance of the following substance(s):

Name of Substance	**Location on National List** NOTE: First reference corresponds to the Location as appears in the NOP full Text. The Second reference (if exists) corresponds to the text published in the Federal Register	**Reason for continued allowance.**	**Supporting Documents (example: research data or other international organic programs**
Ethanol	§205.601(a)(1)	As alguicides, disinfectants, and sanitizers including irrigation system cleaning systems.	NOSB Argumentation
Chlorine Materials - Calcium hypochlorite - Sodium hypoclorite	§205.601(a)(2)(ii) and (iii)	Water Purification	NOSB Argumentation
Soap-based algicide / demossers	§205.601(a)(4) or §205.601(a)(7)	Algicide	NOSB Argumentation
Soap based herbicides	§205.601(b)(1)	Weed Control	NOSB Argumentation
Mulches i. Newspapers or other recycled paper ii. Plastic Mulch and covers	§205.601(b)(2)(i) and (ii)	Weed Control	NOSB Argumentation
Boric Acid	§205.601(e)(2)	Insect Control	NOSB Argumentation
Elemental Sulfur	§205.601(e)(3) or §205.601(e)(4)	Insect Control	NOSB Argumentation

Lime Sulfur	§205.601(e)(4) or §205.601(e)(5)	Insect Control	NOSB Argumentation
Oils, horticultural	§205.601(e)(5) or §205.601(e)(6)	Insect Control	NOSB Argumentation
Soaps, insecticidal	§205.601(e)(6) or §205.601(e)(7)	Insect Control	NOSB Argumentation
Sticky traps / barriers	§205.601(e)(7) or §205.601(e)(8)	Insect Control	NOSB Argumentation
Coopers, fixed	§205.601(i)(1)	Plant Disease Control	NOSB Argumentation
Cooper sulfate	§205.601(i)(2)	Plant Disease Control	NOSB Argumentation
Hydrated lime	§205.601(i)(3)	Plant Disease Control	NOSB Argumentation
Hydrogen peroxide	§205.601(i)(4)	Plant Disease Control	NOSB Argumentation
Lime Sulfur	§205.601(i)(5)	Plant Disease Control	NOSB Argumentation
Oils, horticultural	§205.601(i)(6)	Plant Disease Control	NOSB Argumentation
Potassium bicarbonate	§205.601(i)(7) or §205.601(i)(8)	Plant Disease Control	NOSB Argumentation
Elemental sulfur	§205.601(i)(8) or §205.601(i)(9)	Plant Disease Control	NOSB Argumentation
Elemental sulfur	§205.601(j)(2)	Plant or Soil Amendments	NOSB Argumentation
Humic acids	§205.601(j)(3)	Plant or Soil Amendments	NOSB Argumentation
Lignin sulfonate	§205.601(j)(4)	Plant or Soil Amendments	NOSB Argumentation
Magnesium sulfate	§205.601(j)(5)	Plant or Soil Amendments	NOSB Argumentation
Micronutrients i. Soluble Boron ii. Sulfates, Carbonates, Oxides, or Silicates of Zinc, cooper, iron, manganese, molybdenum, selenium and cobalt	§205.601(j)(6)(i) and (ii)	Plant or Soil Amendments	NOSB Argumentation
Liquid Fish Products	§205.601(j)(7)	Plant or Soil Amendments	NOSB Argumentation
Ethylene	§205.601(k)	Regulation of Pineapple Flowering	SEE NOTE #1, TAP Review and it is allowed according to European and Japanese organic standards.
Inert ingredients EPA List 4	§205.601(m)(1)	Inert ingredients	NOSB Argumentation
Tobacco Dust (nicotine sulfate)	§205.602(f) or §205.602(i)	Insect Control	Allowed by ECC 2092/91 in Europe for Insect Control

Sodium nitrate	§205.602(h) or §205.602(g)	Plant Nutrition	NOSB Argumentation
Citric Acid	§205.605(a)(1)(ii) or §205.605(a)	Post Harvest	NOSB Argumentation
Lactic Acid	§205.605(a)(1)(iii) or §205.605 (a)	Post Harvest	NOSB Argumentation
Nitrogen	§205.605(a)(12) or §205.605(a)	CA Transportation	NOSB Argumentation
Oxygen	§205.605(a)(13) or §205.605(a)	CA Transportation	NOSB Argumentation
Waxes	§205.605(19)(i) or §205.605(a)	Post Harvest Coating	NOSB Argumentation
Ascorbic Acid	§205.605(b)(4) or §205.605(b)	Post Harvest	NOSB Argumentation
Calcium citrate	§205.605(b)(5) or §205.605(b)	Post Harvest	NOSB Argumentation
Calcium hydroxide	§205.605(b)(6) or §205.605(b)	CO2 Level Control – Transportation	NOSB Argumentation
Carbon dioxide	§205.605(b)(8) or §205.605(b)	CA and MA Transportation	NOSB Argumentation
Calcium hypochlorite	§205.605(b)(9)(i) or §205.605(b)	Water Purification, Processing Aid, Disinfecting and Sanitizing	NOSB Argumentation
Chlorine dioxide	§205.605(b)(9)(ii) or §205.605(b)	Water Purification, Processing Aid, Disinfecting and Sanitizing	NOSB Argumentation
Sodium hypochlorite	§205.605(b)(9)(iii) or §205.605(b)	Water Purification, Processing Aid, Disinfecting and Sanitizing	NOSB Argumentation
Ethylene	§205.605(b)(10) or §205.605(b)	Post Harvest	SEE NOTE #2, TAP Review and it is allowed according to European and Japanese organic standards. IBA letter.
Hydrogen peroxide	§205.605(b)(14) or §205.605(b)	Post Harvest	NOSB Argumentation
Ozone	§205.605(b)(20) or §205.605(b)	Air Purification - Transportation	NOSB Argumentation

Note #1: Ethylene gas for regulation of pineapple flowering. This was approved on June 6th of 2000 in Washington by the NOSB with zero votes against its approval. I attached the TAP review on ethylene as a substance and the use in pineapples. In Europe the ethylene use for pineapple flowering was recently approved on July 1st, 2005, based on a fiche document which I am also attaching.

Note #2: Please see letter sent to you by Mr. Tim Debus of the International Banana Association (IBA) requesting the continued use of ethylene for banana ripening.

Sincerely,

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Cc: Organic Trade Association
National Organic Standards Board

Ethylene
Crops

Identification

Chemical Names	ethylene	**CAS Numbers:**	74-85-1
Other Names:	ethene, elayl, olefiant gas	**Other Codes:**	DOT #: UN 1962/UN 1938

Supplemental Information

Ethylene Use on Pineapple

Supplementary information provided to NOSB, to be added to 1999 Technical Advisory Panel review for review of use in crop production. This information was prepared by OMRI staff and did not receive additional review by the initial three TAP reviewers.

Background: At the Oct. 25-27, 1999 meeting the NOSB decided to table decision on ethylene use in crop production pending further information about formulation of materials commonly used. The initial TAP review considered the use of ethephon and calcium carbide as common ethylene generating compounds, and NOSB crops committee requested more specific information on ethephon. Subsequent to that meeting, OMRI received supplemental information to the original petition (Wielemaker, et.al. 98) that ethylene gas can be applied to crops in an aqueous solution. The crops committee agreed to re-examine ethylene applied by this method and requested that OMRI answer the following questions regarding this formulation:

1. What is the source of the ethylene used in this practice and does the discussion of manufacturing ethylene and the impact of that manufacturing that was presented in the TAP review fit this material?

2. Describe in detail the practices of preparing the solution, the materials and equipment used, and the application to the crop.

3. If you think it is necessary after studying the practice, present additional information to what was already presented in the TAP review on the environmental impact of field application of this material.

Response to questions:
1. Source of ethylene, manufacturing impact

As indicated in the original TAP review, the source of commonly used ethylene gas is hydrocarbon feedstocks, such as natural gas liquids or crude oil. MSDS supplied by petitioners and communication with a manufacturer indicate this is produced in a refining process from petroleum. (Spercel, 2000) Ethanol sources of ethylene are in use for older on-site generated units in ripening houses in Florida, but are being replaced due to fire hazards and improved technology with systems using compressed gas cylinders. Active registrants of agricultural grades of ethylene are rated at 99.9999% pure in EPA registrations; others are listed at 95% and 98.5% purity. (EPA-OPP Chemical Database).

Ethylene production in the United States was 46.97 billion pounds in 1995, the fourth largest volume of chemicals produced in the US. Reporting under the Toxic Release Inventory shows that in 1996, some 35.8

million pounds were released, of this amount, 19.6 million pounds were from stack or point emissions, while 16.1 million pounds were nonpoint sources. Releases of over one pound of ethylene to air, water, and land are required to be reported (Env. Health Center, 1998).

Petroleum refining is a major source of non-point air pollution and hazardous waste generation. Ethylene is often considered a by-product in chemical engineering process manuals, and to the extent that it is captured rather than released into the environment can be seen as reducing the ambient air pollution. Ethylene reacts with ozone in the atmosphere to form water, carbon dioxide, carbon monoxide and formaldehyde, though this reaction can reduce ozone air pollution. UV light destroys ethylene in the upper atmosphere, producing hydrogen, acetylene, n-butane, and ethane. (Abeles, 92) The amount released by agricultural use is hard to judge, but can be safely assumed to be a small fraction. If all of Hawaii's 1993 acreage received ethylene at the upper rate described by petitioners, that would amount to 69,620 lbs. for one application (though the fraction of acreage that is at flower induction stage is certainly only a limited percentage of total acreage.) A ranking by industrial sector generated by Environmental Defense Fund from EPA Toxic Release Inventory data shows "food and kindred products" release of ethylene at 36,000 pounds in 1997.

2. Application methods and materials

Prof. Duane Bartholomew, University of Hawaii, has provided information from a book he is writing on pineapple production.

> "Work in Hawaii (Collins, 1960) showed that water-saturated solutions of ethylene applied with a pressurized sprayer could deliver the required quantity of gas. Green leaf tissue is required for forced induction with ethylene presumably because gases are absorbed primarily through the stomata. Forcing with ethylene is most effective at night because the stomates of pineapple typically are open from dusk to dawn, though they also may remain open on cool, cloudy days.
>
> Ethylene properly applied with a pressurized sprayer late in the evening or at night to permit uptake through the stomata is considered to be the most effective forcing agent available. In Queensland, it was used as a saturated solution in 6,500 to 9,000 L ha-1. An alternative was to make two applications of 4,500 L ha-1, 24 hours apart. Activated charcoal at 20 g L-1 was added to the water to increase absorption of the ethylene in the solution. Py et al. (Py, et al. (1987) *The pineapple. Cultivation and uses*. Editions G.P. Maisonneuve, Paris) state that 800 g of ethylene is applied in 6,000 to 8,000 liters of water per hectare with 0.5% activated charcoal or 1% bentonite is added to increase retention of the gas by the water. The water should be cool if possible. I believe the original patent was based on application with a pressurized hand sprayer (Kerns, K. (1936) Method and material for forcing flowering and fruit formation in plants. US Patent No.2, 047,874.)"
>
> He also reports that the engineering of sprayers has been done by the plantations and is used on one large plantation in Hawaii. The common practice is to inject ethylene at fairly high pressure into the water at the pump that moves water into the boom applicator. It has been used elsewhere, but must be applied at night so has been tried but dropped by other growers because of the added cost and difficulty in handling. Primary limitations are that the gas is combustible, is sparingly soluble in water and difficult to retain there so large volumes of water must be used to force plants. Professor Bartholomew's opinion was that environmental hazards would be small as a small amount of the gas is used, against the background of natural ethylene production by a field of plants.

A petitioner also supplied the following information:

> "The actual formulation used is pure ethylene gas which comes in a steel cylinder which is securely mounted on the spray boom vehicle and by means of a flow measuring device the gas (at 2.25 to 3.5 Kg/Ha) is injected into the boom through which abundant water (7014 L/Ha) flows with the charcoal (mixed in the tank). As the ethylene bubbles through the water it gets partially hydrolyzed and partially adsorbed by the charcoal which subsequently releases the ethylene slowly to the plants after it is applied by means of flood nozzles. Two applications are made during two consecutive nights as that is the time when the application is more effective due to the stomata opening. The concentration of ethylene is very low due to high volume of water and does not cause any phytotoxicity. The high volume of water is needed to reach the basal white tissue of the heart leaves." (Weilemaker, Dec. 1999)

Another producer who was also an original petitioner, was contacted. He was not familiar with this technique for ethylene application, but did not feel it would be prohibitive for smaller growers. He reaffirmed the position supported by other producers: that commercial production would not be possible without some type of flower induction material, and described failed efforts at providing natural sources of ethylene, including smoke, rotten bananas, and goat manure. (Johnson, 2000)

Literature review indicates that use of ethylene gas in water was successfully used as an early method for flower induction (Collins, 1960). This technique many be more suited to warm, wet tropical climates (Chadha, 1998) due to slower drying and better absorption by the plant tissue. Many other plant growth regulators have been evaluated for easier application and consistent results in different locations, (Kays, 1987) and one reference considered ethylene gas "normally impractical in the field." (Lurssen, 1982.) University of Hawaii extension fact sheets refer to common use of ethylene saturated water, calcium carbide and ethephon, with most emphasis on ethephon use and rates. (Evans, 1997)

3. Additional Information on environmental impact and human health

The non-profit environmental organization, Environmental Defense, ranks ethylene as less hazardous than most chemicals, using 8 different ranking systems. (Environmental Defense, 2000). Two rankings for integrated human health and environmental effects place ethylene in the lower 50% of all chemicals ranked for hazard.

- The UTN (from University of Tennessee hazard evaluation system) considers toxicity and persistence consideration, as well as human health impact. Ranks ethylene as 0-25th percentile (a numerical score of 31/200) for relative hazards.
- IRCH (the Indiana Relative Chemical Hazard Ranking System from Purdue University) considers toxicity and exposure, and includes ecological and occupational human health impacts. The IRCH ranks ethylene as 25-50th percentile, (numerical score of 19/200) for relative hazards.

UTN uses endpoints of acute toxicity to mammals and chronic and acute toxicity to aquatic organisms as measures of environmental effects. IRCH includes a wide variety of measures relating to toxicity and physical-chemical properties such as vapor pressure, tendency to bio-accumulate, corrosivity and others.

Carcinogenicity: the National Toxicology Program Health and Safety Information Sheet, published by the National Institute of Environmental Health, states that neither the NTP, IARC, (The International Agency for Research on Cancer, part of the World Health Organization) nor OSHA lists ethylene as a carcinogen. (NTP, 2000). The only health hazard listed by Environmental Defense is based on Cal EPA data as a suspected neurotoxicant, at a relatively high level of ingestion by inhalation (20,000 ug/m^3 = 2x10^{-5} (0.00002) kg/m^3). Worker safety is thus a concern, as the density of the gas is listed at 1.169 kg/m^3. EDF identified the lack of basic testing in several categories of toxicity: chronic, reproductive, and neurotoxicity for this high volume use chemical.

Supplemental information:

4. Additional information on regulatory status:

Ethylene is registered by EPA as a pesticide used as a plant growth regulator and as a herbicide (used under a USDA control program for witchweed for numerous crops, causing premature germination). It was designated as a biorational pesticide in 1990, as EPA deemed it "naturally occurring" with a "non-toxic mode of action." (EPA, 1992). Ethylene is exempt from requirement of a tolerance (or maximum residue level) when used as a plant growth regulator on fruit or vegetable crops. (40CFR 180.1016). EPA waived all ecological testing for purposes of re-registration, stating that outdoor uses of soil injection and pineapple sprays result in only negligible exposure to aquatic and terrestrial organisms.

International status:
The European Union Standing Committee on Organic Farming decided at its December 10, 1999 meeting (EU, 1999, Imele 2000) to prohibit the use of "ethylene and calcium carbide" for all imports of organic pineapple, effective Jan. 15, 2001. The minutes state:

> "This would have the consequence that, unless the issue was reviewed on the basis of additional information, organic pineapples producers with the use of ethylene and calcium carbide would not be accepted after 15 January 2001."

Supporting or clarifying information for this decision was not available at the time of this report. A task force of European importers and brokers has been initiated to help fund research into alternative methods of flower induction. Suggested avenues of research include use of smoke under tarpaulins, use of mechanical and heat stress, and investigation of source of naturally derived calcium carbide. (Imele, pers.comm) If a more acceptable source of calcium carbide were developed, it would still require approval as a synthetic under OFPA, since its basic mode of action of reacting with water to produce acetylene and calcium hydroxide remains the same as previously discussed.

5. Discussion
The information reviewed regarding application method, manufacturing and environmental concerns do not indicate that ethylene as used in crop production would present a significant risk, although there are gaps in toxicity data. In addition, the NOSB should consider carefully if this use meets all OFPA criteria. Its use as a synthetic is not specifically listed in the exempt categories of 6517(1)(B)(i) unless it is considered a crop production aid. This term should be more carefully defined for consistent use in decision making on synthetic crop materials.

OFPA 6518(m) Criteria: Description of conformance to these criteria remains as listed in the initial TAP review (Oct. 99).

(1) The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems.

(2) The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment.

(3) The probability of environmental contamination during manufacture, use, misuse or disposal of such substance.
See additional information under point 2 above.

(4) The effect of the substance on human health.
Addressed under point 3 above.

(5) The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock.
Addressed in the initial review (Oct. 99.)

(6) The alternatives to using the substance in terms of practices or other available materials.

Alternatives have not been available on a commercial scale, but it appears that interest from European sources may generate research in this direction. Use of smoke may be a more natural source of ethylene, but environmental consequences of this use are potentially more damaging. According to Kader, et al., some fruits are a better source of non–synthetic ethylene than others are. Tropical fruits have the highest production rates: cherimoya, mammea, passion fruit, and sapote all are rated “very high” producers of ethylene, making over 100 µl of C_2H_2 per hour at 68°F. The highest levels found in the literature are from vanda orchids producing over 3,500 µl per hour at 68°F (Kays, 1991). Papaya is in the “high” range. Generating predictable amounts of natural ethylene in field situation at the correct time would be challenging.

Ethylene can also be derived from ethanol dehydration, though this might also be considered synthetic (ethanol is passed over heated beds of solid catalyst, typically alumina or phosphoric acid). The NOSB has considered the preparation of plant and animal derived substances by methods ordinarily used in food processing to be non-synthetic, and have also considered combustion of biologically derived materials to be non-synthetic in producing ash (NOSB, 1995). Catalytic generators have been used for introducing ethylene gas into ripening rooms, (Kays, et.al. 1987 mentions light weight mobile units powered off vehicle batteries) it is possible the technology could be adapted for field use, to produce renewable sources of ethylene.

(7) Compatibility with a system of sustainable agriculture.

The use of ethylene represents the addition of a synthetic growth regulator in order to manipulate crop production, schedule year round production, and synchronize production in order to achieve economic yields. Pineapples will produce flowers and fruit without the use of ethylene, but fewer of them in a less predictable way. These market goals are not necessarily of primary concern under OFPA, however if sustainable agriculture is considered to include the economic considerations for success of producers, then this practice might qualify as sustainable. One of the original TAP reviewers also commented that an organic system of pineapple production has a vastly better impact on the environment than conventional methods of production. Development of alternatives based on natural sources would avoid the precedent set by adding a synthetic plant growth regulator to the National List, and the subsequent petitioning for other PGRs that are synthetic analogs of natural substances or the extension of use of ethylene to other crops.

If NOSB decides to approve use of ethylene in crop production, annotations could include:

Use as a plant growth regulator only for floral induction in pineapple. All safety requirements during application and handling must be strictly followed.

Additional References

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Wielemaker, Frans, Dr. Jorge We. Gonzales et. al. Letter to Mr. Ted Rogers, NOP dated April 15, 1998. Subject: Calcium carbide and ethylene use for pineapple production.

Wielemaker, Frans. Dec. 28, 1999. Personal communication. Subject: Information on Ethylene as requested.

REQUEST TO AMEND ANNEX II B - Pesticides

Request for inclusion

Introduced by: The Netherlands
Date: February 2003
Contact e-mail: w.l.reerink@minlnv.nl

Name	Description, compositional requirements, conditions for use
Ethylene	Flower induction for pineapple production.

1. Identification

Chemical name(s) of active substance: ethylene
Other names: ethene, elayl, olefiant gas
Trade names: (bananas gas)
CAS name: 000074-85-1
IUPAC name: ethylene
Other code(s): UN 1962/UN 1938

2. Characterisation

Composition: C_2H_4 (CH_2=CH_2)
Concentration of active substance: 5-N material (99,999%) (EPA-registration)
Physical properties: a colourless gas at room temperature with characteristic slightly sweet odour. The gas is flammable and soluble in water. Ethylene gas is more than 99,99% pure gas, which is sold in gas cylinders. Ethylene gas is dissolved in water and sprayed over the pineapple plants.
Origin, production method: Prepared by decomposition of petroleum gases or by dehydration of alcohol. Petroleum refining is a major source of non-p-oint air pollution and hazardous waste generation. Ethylene is often considered a by-product in chemical engineering process manuals, and to the extent that it is captured rather than released into the environment can be seen as reducing the ambient air pollution. Ethylene reacts with ozone in the atmosphere to form water, carbon dioxide, carbon monoxide and formaldehyde but only in absence of sufficient oxygen,[1]. Ethylene is also produced by all cut plant tissues and in abundant quantities by ripening fruit[2].
Formulation: Ethylene is a liquid at low temperatures and a gas at room temperature and soluble in water.
Effect on harmful organism and action mechanism: - possible effects: No harmful effects are observed when used to induce flowering. Ethylene is not listed as a carcinogen and is naturally occuring[2]. - action mechanism: ethylene treatment signals the plant to flower through plant growth regulating receptors. Other triggers are unpredictable extreme weather (cold) periods that trigger ethylene production by the plant itself and thus flower formation. A uniform controlled induction is needed for uniform flowering of all the plants in one whole field. Natural flowering of pineapple is erratic inconsistent and not uniform. There are no pineapple plantations where flowering is synchronous and uniform unless some sort of flower induction treatment is carried out (see also point 5). In non-organic conventional pineapple plantations a

[1] Environmental Health Center, 1998, Ethylene background (www.nsc.org/library/chemical/Ethylene.htm)
[2] OMRI submission fact sheet 2001/2002/ Ted Rogers, 1998 (email.).

synthetic compound called ethephon is sprayed on the fields. This compound is not a natural compound but ultimately also emits ethylene in order to have the same effect.
Selectivity: not applicable.

3. Uses

Use category: used as a traditional flowering agent, purpose is uniform flowerbed development, in the organic agricultural production system as a pre-harvest treatment of pineapple plants" (Annex II, part B, section IV after ripening of bananas: "flower induction of pineapples") [3].
Application method: pure ethylene gas is used, which comes in steel cylinders and is securely mounted on the spray boom vehicle and by means of a flow measuring device the gas is injected into the boom through which abundant water flows with the charcoal (mixed in the tank). As the ethylene bubbles through the water it gets partially hydrolysed and partially adsorbed by the charcoal which subsequently releases the ethylene slowly to the plants after it is applied by means of flood nozzles.
Dosage: at 2.25-3.5 Kg (ethylene) per hectare with an excess of water >7000L/ha. The amount of activated charcoal is app. 0,5% of the total.
Application at stage of plant development: applied to (mature) plants; older than 8 months and app. 5 months before harvest[4].
Application frequency: depending on rainfall, once or twice (both can be applied at two times half the dosage to obtain greater uniformity) per crop cycle, which can be 12 to 18 months from planting to harvest. The red bud of the developing flowers will be visible in the hart of the plant at 48 – 60 days after the application of the ethylene for the induction.

4. Status

Historic use: before the EU ban after 15[the] of January 2001 ethylene was widely used in organic pineapple production[5]. Ethylene is still used in different countries all over the world for organic pineapples. The use of ethylene gas is allowed according to the United States organic regulations known as NOP[6]. Already in the 1900's ethylene has been recognized as a plant own product or by-product. It rapidly became commercially used to ripen fruits (for instance citrus and bananas). In 1936 ethylene was first used for the induction of pineapple flowering[2].
Regulatory status: ethylene is registered on the list of active substances on the market in plant protection products on 25 July 1993 (Article 4 of Council Directive 91/414/EEC)[7]. In Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications, the use of ethylene is permitted for the degreening of bananas (annex II, part b).

5. Criteria article 7

Necessity: flower inducing of the pineapple plant is necessary for the following reasons: ▪ To reduce the losses due to serious insects damage, and to reduce the use and the time

[3] Chase,E.M., 1934 ethylene treatment of fruits. Am. Journal of Public Health 24: 1152-1156.
[4] Rogers, T., April 1998 (e-mail).
[5] http://europa.eu.int/comm/agriculture/minco/regco/agbio/1012.pdf
[6] http://www.ams.usda.gov/nop/indexIE.htm
[7] http://europa.eu.int/comm/food/fs/ph_ps/pro/eva/existing/exis02b_en.pdf

period during which (organic) pesticides are needed. A uniform synchronous flowering period results in a relative short(er) period in which attractive stages of the pineapple flower is available for insects in the same field. Well-timed cycles of an organic pesticide (based on the bacterium *Bacillus thuringiensis*) can protect the whole field. An additional effect can be expected since the growers are able to control possible plague(s) better since they know in which area insects might ‘flourish’ and can control these plague(s) in the smaller area.

- Controlled flower induction prevents induction of immature plants triggered trough ethylene production of flowering plants within the same field. Flowering of non-mature plants, with underdeveloped root systems, which are necessary for sufficient nutrient flow for fruit filling, results in poor and small fruits, which are not marketable.
- When flower induction applications (with ethylene) are timed and thus done at an optimum plant size (plant weight), all the plants in field will be able to bear a fruit the size in proportion and according to the capacity of the plant to fill the fruit.
- To be able to produce for overseas markets a producer will need to supply clients and ultimately the consumer with fresh pineapples on a regular basis. Ethylene applications synchronize flower induction and thus fruit set. This reduces the harvest picking rounds from a dozen or more to 3 to 5. Without the use of ethylene the percentage of market ready fruit would be very low and erratic in the same field. It would take a dozen of harvesting rounds to pick all the fruit under a natural setting. Damage to the plants and the fruit left in field some time more, and soil compaction will be increased when the equipment for harvesting needs to go trough the fields a dozen times instead of a few times. For transport and marketing reasons certain quantities are necessary in order to make it commercially feasible to grow pineapples.
- For the potential organic pineapple markets it is important to be able to produce fruits of top quality all year round. Flower induction by ethylene applications allows programming harvests all year round and employing a steady labour force all year round, which contributes to the economic welfare and stability of the areas in the tropics where pineapples are grown.
- Through the application of ethylene the total crop cycle will be reduced by several months if not almost a year, as there will be no endless harvest tail. The production efficiency of the organically certified land as a valuable natural resource will be increased and making it more attractive as a farming option, leaving more time for leaving fields fallow, growing green manure, grow a rotation crop, or plant the next pineapple crop.

6. Other aspects

Human health and quality: According to research: ingestion, inhalation and human health effects are considered low. The EPA (environmental protection agency, based in the USA)[8] has registered ethylene since it is naturally occurring and it has been widely used as anaesthetic since 1923 without report of significant toxicity. According to the EPA the potential risk from the use of ethylene are considered negligible because ethylene is low in toxicity and highly volatile (i.e. exposure to skin and lungs is minimal). Ethylene gas is also allowed for the ripening of organic bananas (in ripening chambers). The time between application of ethylene and the consumption of the organic bananas is less than seven days. The ethylene application for pineapples is at least 130 days before the moment of consumption. The pineapples will produce ethylene itself as they get ripe, and possible residues on the final product as a result of the ethylene gas application 5 months earlier are no different, and chemical analyses can therefore not differentiate between the two.
Socio-economical aspects: The ethylene gas itself is inexpensive, especially since the amount used is limited. The requirement mechanical equipment is easy to assemble and can be used by multiple users for a number of years to limit the costs. Also, “small”-farmers will be in the position the apply ethylene. Small containers to limit the start-up costs are available.
Alternatives: in open air fields, no known alternatives have been found successfull. ▪ Smoke: the use of smoke from combusted wood or other materials is only successful in a contained area (i.e. greenhouse). Greenhouses are not only too expensive in most (sub) tropical area’s, but will also result in too high temperatures inside the greenhouse for these regions. Smoke, containing ethylene as the active substance as well, used outside of a greenhouse will drift and gets blown over the land too fast and therefore will not result in flower induction, since the concentrations of the active ingredient is not high enough. ▪ The use of calcium carbide is and has been used as an alternative in some parts of the world. Dissolved in water, again ethylene (C2H4) is released by a reaction of carbide with water. A reported problem, as mentioned in the NOSB TAP review made for the NOP approval, with the use of calcium carbide is the formation of several toxic by-products due to the impurity of the calcium carbide, like fosfine, phosphorous hydride (PH3) and arsenic hydride (AsH3)[9], and therefore was rejected as an alternative. On the other hand the use of calcium carbide is supposed to be cheap and easily accessible for all pineapple producers. More research must be carried out to investigate the remaining questions regarding the use of calcium carbide. The use of already ripened fruit, which releases ethylene gas is not a realistic alternative. Ripened fruit attracts large amount of insects and pineapple pests and therefore will result in a bigger need for the use of natural or biological pesticides. Furthermore it does not fit in sustainable agriculture to use large amounts of eatable fruit to produce other fruits. Secondly it is not commercially viable to harvest ethylene gas produced from ripened fruits in a concentration that can be compressed into a cylinder without purifying it first, which is expensive and a dangerous process ▪ The use of cold water or bovine urine was reported as being practised for a short time but did not result in a desired uniform flowering[10].

[8] www.epa.gov
[9] NOSB materials database, 25 November 1999
[10] Personal communication Martijn van Es, , 2002

7. Conclusion

The use of ethylene gas is necessary for the uniform flowering of a pineapple field. This approach enables the growers to produce marketable size and good quality fruit in sufficient quantity from the same field at the same time with limited use of (natural) pesticides.
Without ethylene only a limited number of ripe fruits can be collected at any given time from the same field and only during certain times of the year, which results in great difficulties to organize the harvest and transport to the markets (except some air-freighted volumes). The use of ethylene for flower induction of organically grown pineapple will result in an increase of economic activity in those third world countries which grow pineapple but want to grow this crop organically. A long 'tail' in the harvest cycle increases damage to the plants and to fruit left in the field for the next rounds. Soil compaction significantly increases due to the significantly more harvesting rounds.
At this moment there are, except for calcium carbide, no known substitutes for ethylene for pineapple flower induction in (sub) tropical regions, which is why hardly any organically grown pineapple can be found on the European market.

8. Annexes

1. NOSB materials database, November 25, 1999. and of 18 February 2000.
2. The flowering process in Organic pineapples, document summary, 30 March 2001.
3. OMRI submission fact sheet 2001/2002.
4. Ted Rogers, 15 April 1998 (email.). Calcium carbide and ethylene for pineapple induction
5. Christine van Horn 23 May 2000, Ethylene and pineapple
6. Ethylene petition submitted to the EU Standing comity on Organic Framing on 15 May 2001.